instruction manual

Beckman®

Berkeley Division

INSTRUCTION
MANUAL

Lot 5 and up
Serial 201 and up

Model 2105
DECIMAL SCALER

BERKELEY division of
Beckman Instruments, Inc.

Richmond 4, California
15 December 1953

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Figure 1 Utility Scaler, Model 2105

Supplement 1
Model 2105
Lot 2 and up

Two features not discussed elsewhere in the Instruction Manual have been added to this instrument:

1. A CRO output terminal for viewing the input amplified waveform with a a cathode-ray oscilloscope has been provided. This terminal and a convenient ground terminal are located on the rear of the chassis. The output is taken from a cathode follower in the conventional manner so that a high impedance oscilloscope probe is not required.

2. An additional pair of contacts has been added to the reset switch which are normally open until the button is depressed. These contacts are sequenced so that they close first and open last with respect to the other switch actions associated with the reset button. Circuit-wise the added contacts hold relay K-103 energized until the other reset operations have been completed. This enables one to use the reset button as a "push-to-reset", "release-to-start" control when set for automatic operation. The "Count" switch need not be changed from its "on" position when operated in this manner with a Model 832 or 833 Time Clock attached.

   When used with a Model 802 Automatic Timer, the Model 2105 cannot be operated in the above manner. The "Count" switch must be turned off in order to reset the Model 802 Timer.

Section 1
INTRODUCTION

The Berkeley Model 2105 Decimal Scaler is a laboratory counting instrument designed to register electrical pulses transmitted by nuclear particle detectors of both self-quenching Geiger-Mueller and scintillation types (see Figure 1). If the input pulses are properly shaped, other pulse sources may also be used (see Section 3).

Basically, the Model 2105 provides a regulated high voltage to operate the detector, registers detector pulses electronically to 99 and electromechanically to 999,999, and supplies the necessary power for the operation of auxiliary equipment. Additionally, the instrument contains an automatic control which stops counting and auxiliary equipment at a predetermined count.

Accessories

The following Berkeley accessories can be directly connected to this instrument:

Model 832 Time Clock, capacity 999.99 min,
117 volts a-c at 60 cps

Model 833 Time Clock, capacity 9999.9 sec,
117 volts a-c at 60 cps

Model 802 Automatic Timer, range 2 sec to 20 min,
117 volts a-c at 60 cps

Model 1600 Counting Rate Computer

Model 2250 Scintillation Vial Counter

Model 2255 Scintillation Gamma Counter

Table 1
SPECIFICATIONS

Counting Circuit

Input Sensitivity	Responds to negative pulses of 1 μsec rise time or less, 0.25 volts minimum and 150 volts maximum.
Resolving Time for Pulse Pairs	6 μsec for rectangular input pulses.
Maximum Average Counting Rate	1000 cps.
Maximum Register Capacity	999,999 counts.

High Voltage Power Supply

Range	Continuously adjustable, 300 to 2500 volts d-c.
Polarity	Wired at factory for positive high voltage output with respect to chassis. Polarity may be easily reversed.
Load Capacity	Less than 1500 v, 600 μamps; 1500 to 2500 v, 250 μamps.
Load Regulation	For a positive output, the effective internal impedance if the load current changes 200 μamps or less is 25,000 ohms; negative output, 50,000 ohms.
Line Voltage Regulation	High voltage varies less than 0.3 volt per volt line change from 105 to 125 volts.
Voltage Drift	Following a 30 minute warm-up, high voltage drift is less than 15 volts over an 8-hour period.
Meter Accuracy	±5% absolute, resettability ±½% of full scale.

Predetermined Count

Counting can be stopped at 10, 20, 40, 100, 200, 400, 1000, 2000, 4000, 10 000, 20,000 or 40,000 counts.

Power Supply

Primary Power Potential	105 to 125 volts.
Frequency	50 to 60 cps
Power Consumption	115 watts.
Fuse Protection	3 amps.

Physical Specifications

Dimensions	16-3/4" wide x 10-3/8" high x 14-1/4" deep.
Weight	49 pounds.

Section 2
OPERATION

Installation

The Model 2105 requires no special installation procedure. It may be operated in any location or position with a clearance of several inches on each side for ventilation. The unit is designed to operate from a power source of 117 volts, 50 to 60 cps, at a power consumption of 115 watts. Proper operation may be obtained over a voltage range of 105 to 125 volts.

Operation

To put the scaler in operation, connect the power cable to a 117 volt, 50 or 60 cps power source and with the H. V. switch in the OFF (down) position, turn the power switch ON. After a one minute warm-up, the high voltage may be turned ON.

> **CAUTION**
>
> The high voltage connected to the G-M input and H. V connectors is dangerous. Do not touch the terminals unless high voltage is off..

To operate a G-M tube, the H. V. control should be turned to the extreme counterclockwise position and the H. V. switch turned OFF. Then the G-M tube can be connected to the G-M INPUT connector through the input cable. Use a suitable radioactive source to indicate when the counting starts.

Turn the COUNT switch ON and the AUTO-MANUAL switch to MANUAL. Turn on the H. V. and slowly advance the H. V. control clockwise until counting just begins. This value of high voltage is the G-M tube threshold. It is usual practice to set the operating high voltage 50 to 100 volts above the threshold value. The plateau width of most G-M tubes is 200 volts or greater. The high voltage should be kept below the upper limit of the plateau to prevent damage to the G-M tube. For automatic operation, turn off the COUNT switch and place the AUTO-MANUAL switch on AUTO. Select the desired count on the PRE-DETERMINED COUNT switch, and set both the register and DCU's at zero. Turn on the COUNT switch and wait for the desired count.

During automatic operation, always push the RESET button after changing the setting of the PREDETERMINED COUNT switch to preclude the possibility of erroneous results. To insure that the microswitches fall to zero when the register is reset, rock the reset wheel up and down after the zeros appear.

The reset button may be used as a "push to reset-release to start" control on automatic operation. The count switch need not be changed from its position when operated in this manner with a Model 832 or 833 time clock attached. Used with a Model 802 Automatic Timer, the Model 2105 cannot be operated in the above manner. The count switch must be turned off to reset the Model 802 timer.

A. C. R. O. output terminal for viewing the input amplified waveform is located on the rear of the chassis The output is taken from a cathode follower precluding the necessity for a high impedance oscilloscope probe.

Use the PULSE INPUT connector to count pulses from any source but a G-M tube. The potential with respect to ground of any connection must be less than 500 volts. This scaler is factory connected for a positive high voltage output. To secure a negative high voltage output, proceed as follows:

1. Remove the instrument from its cabinet. The plug-in high voltage power supply can be removed from its socket and the proper terminals exposed by taking off both side covers. These terminals are identified by three color-coded stand-off insulators on each side of the plug-in unit. On each of these groups of insulators, the bare wire connecting the center insulator to the red insulator should be changed to connect the center to the green insulator.

2. Reverse the connections on the high voltage meter.

3. Make two wiring changes on the terminal board on the under side of the chassis. One of these consists of moving R174 (4. 7 meg) from its connection to R170, the plate resistor of V109 (see Fig. 5) to the adjacent resistor R169 (680K), connected to the other plate of V109. Now move the bare wire from R164 to R163 (63K). Since the polarity of the high voltage is not marked on the chassis, it should be written on the chassis at this time.

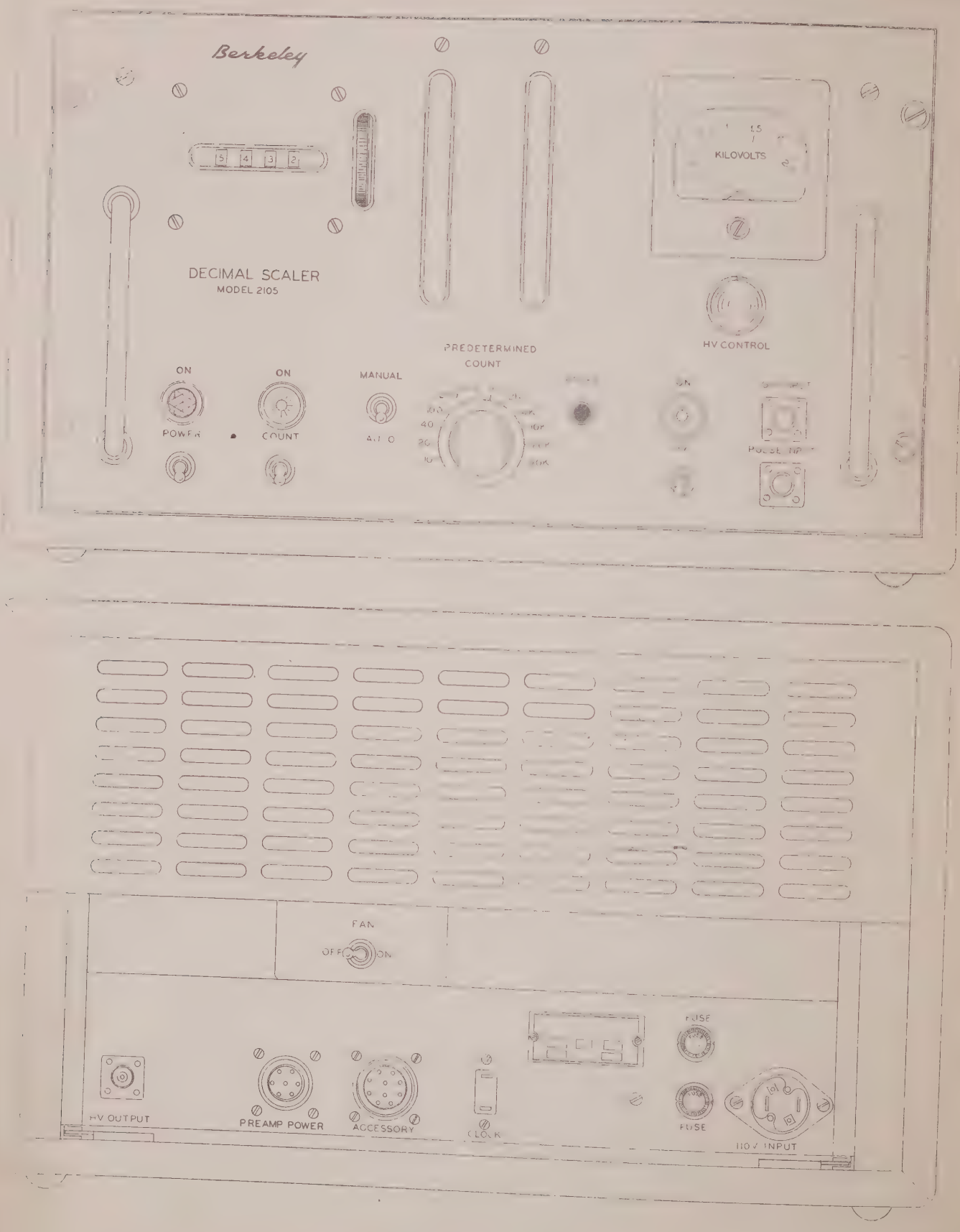


FIGURE-2, OUTLINE VIEW FRONT AND REAR PANELS

Table 2
CONTROL AND CONNECTOR FUNCTIONS

Name of Control	Circuit Desig.	Component	Function
		Front Panel	
Power	S106	DPST toggle	Disconnects both sides of the 117 volt line from the instrument in the lower position.
Count	S103	DPDT toggle	Controls counting operation.
Auto-Manual	S102	DPDT toggle	Controls operation. *
Predetermined Count	S104	4-pole, 12 position	Selects desired count for auto-manual operation.
Reset	S101	DPST pushbutton	Resets DCU to zero and control binaries to initial condition and prevents clock from running until counting starts.
H.V.	S105	DPDT toggle	High voltage on or off.
H.V. Control	R165	100K potentiometer	Adjusts high voltage.
Pulse Input	J101	BNC type connector	Direct connection to input amplifier through 500 $\mu\mu$f capacitor.
G-M Input	J102	High voltage connector	Direct connection to input amplifier through 50 $\mu\mu$f capacitor and high voltage through 1 megohm resistor for direct operation of G-M tube.

* In MANUAL position, the count switch controls counting operation. An external register or a Model 1600 Counting Rate Computer can be operated with the scaling factor determined by the predetermined count switch. In AUTO, counting will automatically stop when a predetermined number of counts has been received.

Table 2 (cont'd.)

Name of Control	Circuit Desig.	Component	Function
		Rear of Chassis	
H. V. Output	J105	High voltage connector	Direct connection to high voltage.
Preamp Power Output	J108	AN13102A-16S-1S connector	Supplies +200 v. d-c, -108 v d-c, 6.3 v. a-c, and ground.
Clock	J103	Standard flush type female connector	Supplies 117 v. a-c during counting operation.
117V. Input	J107	Standard recessed male plug	Main power input.
Accessory	J104	AN3102A-18-1S connector	Supplies power and control signals for accessory operation.
Fuses	F101 F102	2-3 amp.	In series with each side of 117 v. a-c input.
Fan	S107	SPST toggle	Disconnects power from fan motor.
CRO Output	E101	Bending post strip	Provides CRO output of amplified input waveform.

Table 3
ACCESSORY SOCKET CONNECTIONS

Pin	Function	Voltage
A	Ground (Chassis)	--
B	Counting rate meter connection	+300
C	A-C line 1	117 A-C
D	A-C line 2 through contact K102-B	117 A-C
E	A-C line 2, when S103 is "ON"	117 A-C
F	A-C line 1	117 A-C
G	Auxiliary count control	
H	A-C line 2	117 A-C
I	Bias and reference voltage source	-108
J	B+	+200

Section 3
THEORY OF OPERATION

The basic circuits in the Model 2105 Decimal Scaler are an input circit, electronic scale of 100, mechanical register, count control circuit which includes an automatic predetermined count feature, regulated high voltage supply and low voltage supply (see Figure 3).

Circuit Analysis

Input circuit. - The input pulses are introduced at the amplifier tube (V101) directly from a G-M tube through the G-M INPUT connector (J102) or from a scintillation counter or preamplifier through the PULSE INPUT connector (J101). This tube (V101) is used as a simple pentode amplifier whose gain can be adjusted by the potentiometer R106.

Negative pulses fed to the input connector produce amplified positive pulses on the plate of V101. These positive pulses are R-C coupled to a trigger circuit (V102) through R107 and C105. The small time constant of this coupling network (0.9 μsec.) insures that the pulse applied to the trigger circuit is never wide enough to cause double counting.

The trigger circuit consists of a cathode coupled univibrator which uses a 12AT7 (V102). This circuit produces a positive output pulse of constant shape and amplitude. The trigger output pulse is taken from the second plate of V102.

The DCU drive tube (V103) is a triode amplifier whose plate resistors (R113, R114 and R115) and grid bias are chosen so that the trigger output pulse will produce the properly shaped negative driving pulse 90 volts in magnitude with a 1 μsec. rise time and 2 μsecs. duration. The DCU driving pulse is taken from the junction of R114 and R115. A similar seven volt pulse which appears at the junction of R113 and R114 is connected to pin B of the accessory socket so that either an external counting rate meter or aural monitor can be operated. The second half of V103 is used as a cathode follower to provide a low impedance output for viewing the amplified input waveform.

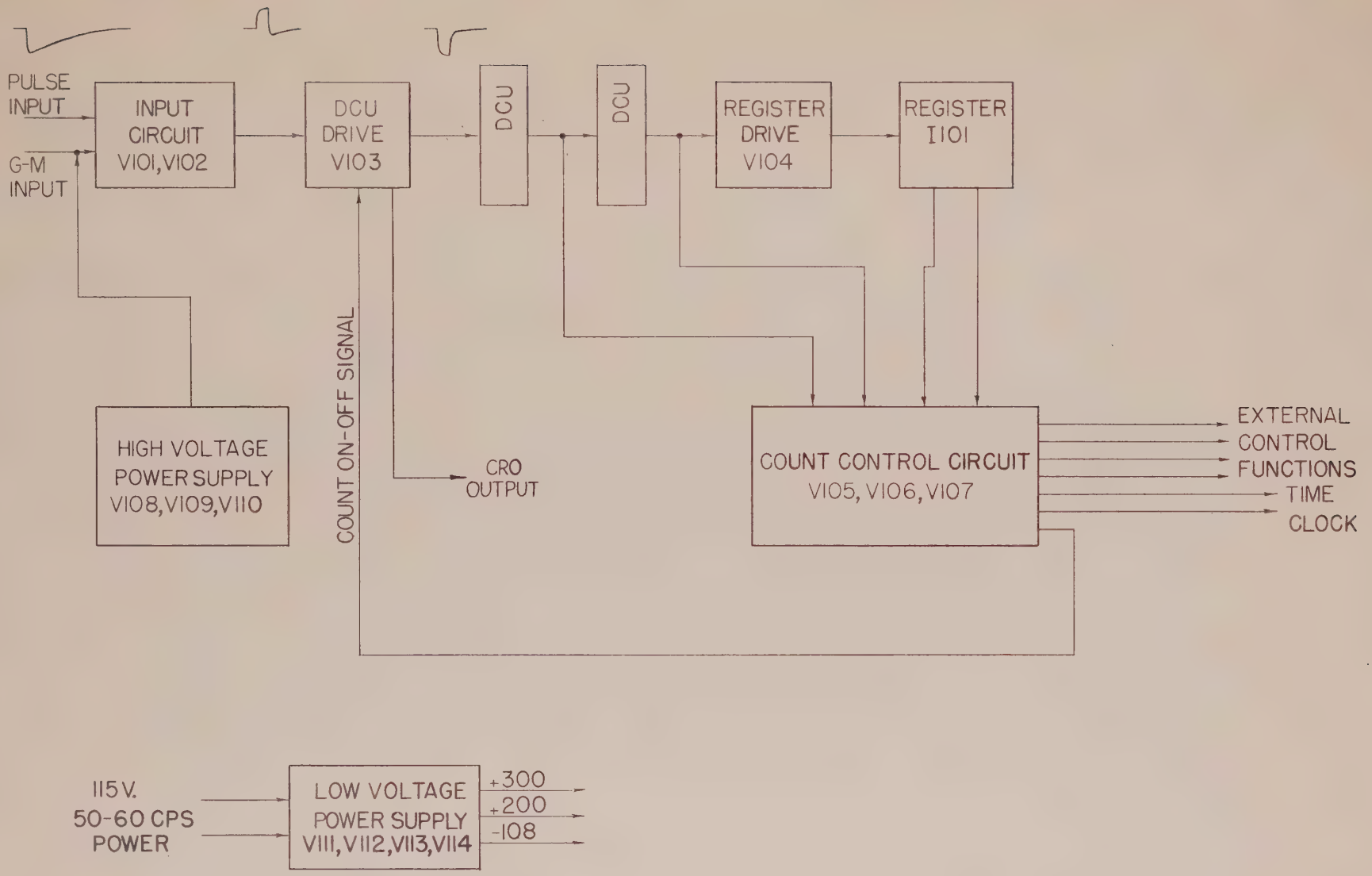


Figure 3 Functional Diagram, Model 2105

The DCU counting process is started and stopped by switching the grid bias on the DCU drive tube through the count control relay (K103) (see page 13). When the count is ON the bias is about 35 volts; OFF approximately 75 volts. The latter value is such that the trigger output pulse from V102 cannot drive V103 to conduction.

Electronic scale of 100. - The electronic counting circuit consists of two Model 705A DCU's connected in cascade. For a complete description of these units, see Appendix A.

Mechanical register and register drive circuit. - For every 100 counts delivered to the DCU's, the mechanical register counts once. This is accomplished by means of the register drive circuit consisting of V104 and relay K101 (see Figure 5).

The negative transient obtained from pin 3 of the second DCU (occurring with the 100th count received by the DCU's) is inverted by the first half of V104. Direct coupling from the first plate to the second grid turns on the second half of V104, energizing relay K101 and causing the registration of one count. Relay K101 closes for approximately 30 milliseconds, a period determined by the R-C coupling between pin 3 of the DCU and V104.

The connection of the relay coil (K101) to ground is made through one contact of the reset switch (S101) to circumvent the effect of the negative transient at pin 3 when the reset switch is operated at a count of "6" or greater on the second DCU. If the register drive circuit were not disabled prior to resetting, an extra register count would be introduced. A third set of contacts keeps relay K103 energized until the other reset operations have been completed. The contacts on the reset switch are sequenced to keep relay K103 energized first, disconnect relay coil K101 second, and reset the DCU's and control binaries last, thus the third set of contacts close first and open last.

Two microswitches, part of the mechanical register, are operated on the 10th and 100th register count. They are an integral part of the count control circuit described below.

Count control circuit. - The basic functions of the count control circuit are:

1. In MANUAL operation, to start or stop the counting whenever the COUNT switch is turned ON or OFF.

2. In AUTOMATIC operation, to stop the counting when a predetermined number of counts has been received.

3. To provide power to an external time clock connection whenever the counting is ON.

4. To provide various other control connections during the counting process for the operation of accessories.

As mentioned earlier, the counting process is turned on and off by switching the grid bias of the DCU drive tube through relay K103. This relay also connects 115 volt a-c power to the clock connector, J103 (clock power is ON only during the counting period). The count control relay (K103) can be operated by the front panel COUNT switch, by contacts on relay K102 when switch S102 is in the AUTO position, and by connecting pins G and H on the ACCESSORY socket (J104).

When S102 is in the AUTO position, the counting automatically stops after 10, 20, 40, 100, 200, 400, 1000, 2000, 4000, 10,000, 20,000 or 40,000 counts have been received, according to the position of the PREDETERMINED COUNT switch, S104. Three binaries, V105, V106 and V107, similar to the type used in DCU construction, are used in this circuit. The first two binaries connected in cascade are used as scaling units, dividing the signal frequency by two and four, respectively, and the third a latching circuit, controls the activity of relay K102. For instance, if the predetermined count is 10, 20, or 40, the output pulse at pin 3 of the first DCU is used. At 10, the pulse is directly connected to the latching binary (V107), energizing relay K102 on the tenth count which in turn energizes relay K103, stopping the counting. At settings of 20 and 40 the output triggers the first scaling binary (V105) on every tenth count. The latching binary is connected to the output of the first scaling binary (V105) on 20 and the second (V106) on 40, energizing relay K102 on the 20th and 40th counts, respectively. At 100, 200, and 400, the output of the second DCU is used rather than the first.

At 1000, 2000, 4000, 10,000, 20,000 or 40,000, the microswitches on the mechanical register trigger the latching and/or the scaling binary. An RC network connected to the microswitches produces a negative triggering transient. Once counting is stopped, it can only be started by pushing the RESET switch, which resets the three control binaries as well as the DCU's.

When S102 is in MANUAL, relay K102 no longer energizes K103 and the latching binary (V107) functions as a univibrator. As a univibrator, V107 still energizes relay K102, but only momentarily (for approximately 30 milliseconds). Thus in the MANUAL position, relay K102 is energized on every nth count where n is the setting of S104, yielding a pulsed supply of 117 volt a-c power at pins C and D of the ACCESSORY socket (J104) which permits the operation of an external register or the Berkeley Model 1600 Counting Rate Computer.

Regulated high voltage supply. - The high voltage source, a separately encased plug-in unt, consists of a reversed feedback r-f oscillator using an air core transformer in the tuned plate circuit (see Figure 5). Voltage from the secondary winding of this transformer is fed to a 1X2A (501) half-wave rectifier to provide d-c high voltage. The 300 kc operating frequency is dependent ypon, but not equal to, the self-resonant frequency of the transformer secondary which is determined by the secondary inductance and the interwinding capacity. The primary circuit is tuned by a variable capacitor, C504 (20 - 125 $\mu\mu$f) to an optimum operating frequency. By changing two connections within the r-f supply unit, the polarity of the high voltage output may be reversed. With the two center junctions connected to the red terminals, the output is positive; connected to the green terminals, negative.

To regulate the high voltage supply, the r-f output is controlled by the screen grid of V502, the oscillator tube. The regulator amplifier, consisting of tubes V109 and V110, obtains the error signal from the H. V. output terminal through a divider network, R166, R167 and R168. Any change in the high voltage output appears as an amplified change in the cathode potential of the second half of V110 which is connected to the screen grid of the r-f oscillator tube. Hence, changes in the screen potential tend to cancel high voltage fluctuation caused by line voltage variations, changes in tube characteristics, or oscillator parameters.

Figure 5 shows the regulator circuit wires for positive high voltage with respect to ground. For operation with negative output, R174, connecting V109 to V110, must be connected to the right-hand plate of V109 to maintain the proper polarity relationship between changes in high voltage and changes in oscillator screen grid voltage. Additionally, the voltage reference tube must be connected to the +200 volt supply through R163, reversing the polarity of the voltage appearing across the control potentiometer (R165), and the H. V. meter terminals must also be reversed.

Potentiometer R165 functions as the H. V. control. The H. V. output can be varied from 300 to 2500 volts by varying the oscillator screen potential between 0 and 30 volts. Owing to the large gain of the regulator amplifier, a change of 30 volts on the oscillator screen can be produced by a few hundredths of a volt change at the input grid of V109. As R165 is moved from one end of its range to the other, the high voltage output must change proportionally to assure a change of only a few hundredths of a volt at the input grid of V109.

Low voltage power supply. - Voltages required for operation of the scaler circuits are:

(a) +300 volts unregulated, 45-65 ma.
(b) +200 volts regulated, 20-25 ma.
(c) -108 volts VR tube regulated, 5 ma.
(d) 6.3 and 117 volts a-c.

Section 4
MAINTENANCE

Routine Servicing

Adjusting input sensitivity. - Connect a negative pulse source (pulses should be 0.25 volts in magnitude with a rise time of 1 microsecond or less) to either input connector with the high voltage turned off. Adjust R106 so that counting barely occurs; the slightest counterclockwise turn halts counting.

Tuning oscillator for optimum H.V. output. - When either high voltage supply tube is replaced, it may be necessary to re-tune the oscillator. To tune this circuit, adjust C504 by turning the screw on top of the Model 728 plug-in unit. For optimum output, connect a two megohm load between the HV OUTPUT connector and ground, and tune C504 for a maximum reading on the H.V. meter. This resistor, which should be rated at 2500 volts, can be easily fabricated by putting six 330K, one watt resistors in series.

Cleaning high voltage points. After long periods of operation, dust accumulated on terminals and components which are at a high potential may cause leakage across insulation. Occasionally it should be removed with a brush, dry cloth or air jet.

Cleaning relays. - Dust on contacts and pole pieces of the relays should periodically be removed with a piece of paper or an air jet.

Trouble-Shooting

To aid in trouble-shooting, the voltages existing at various points in the circuit are marked on the schematic diagram (see Figure 5). These voltages occur with a 117 volt line voltage and should be measured with a vacuum tube voltmeter with at least 10 megohms input impedance.

In the following chart of troubles and possible causes, only the more likely causes are mentioned. Since tube failure is the usual fault, replacement of the suspected tube is the first step. Should the trouble persist, failure of an electrical component or wiring can be investigated with the aid of a voltmeter and an oscilloscope. An oscilloscope with input impedance of 10 megohms shunted by no more than 20 $\mu\mu$f should be used (see Figure 4A and 4B for typical waveshapes).

Table 4
TROUBLESHOOTING CHART

Power supply. - Since many troubles can be caused by improper supply voltages, the power supply should be checked when trouble occurs in any part of the instrument.

Trouble:	Unregulated B+ lower than +300 volts.
Possible Cause:	Failing rectifier tube V111.
Trouble:	+300 volts normal but regulated B+ lower than +180 to 200 volts.
Possible Cause:	Bias voltage has dropped below 108 volts. Failing series regulator tube V112.
Trouble:	Improper bias value.
Possible Cause:	Failing VR tube (V114). Failure of selenium rectifiers (CR102 or CR103). Failure of dropping resistors (R184 or R192).

Input circuit.

Trouble:	Sensitivity of 0.25 volts cannot be achieved.
Possible Cause:	Failing amplifier (V101). Failing trigger tube (V102).
Trouble:	No counting occurs.
Possible Cause:	Failure of amplifier (V101), trigger tube (V102) or DCU drive tube (V103). Improper operation of the count control relay (K103) - contacts may be dirty or out of adjustment. Failure of first DCU (see DCU instructions).
Trouble:	Stray counts.
Possible Cause:	Intermittent failure of a resistor or capacitor in the input circuit. Failure in power supply causing large ripple on B+. Failure in H.V. supply causing fluctuations in H.V. output.

Decimal counting units. - See Appendix A.

Register

Trouble: Register does not operate.
Possible Cause: Register drive tube does not operate relay K101.
Failure of contacts on relay K101.

Count control binaries

Trouble: Relay K102 does not operate, either in MANUAL or AUTO operation or in any setting of PRE-DETERMINED COUNT switch.
Possible Cause: Latching circuit failure involving tube (V107) or component.

Trouble: Predetermined count of 10, 100, etc. can be obtained, but 20, 200, or 40, 400 etc. cannot.
Possible Cause: Failure of control binary (V105 or V106).

CAUTION !

A serious shock can be obtained

from the high voltage supply.

High voltage supply

Trouble: Full 2500 volts output cannot be obtained.
Possible Cause: Meter giving incorrect reading due to increase in value of meter resistors R161 or R162.
Failure of any of the regulator amplifier tubes (V108, V109 or V110).
Failing RF oscillator tube V502 or rectifier tube V501.

Trouble: H. V. shows off-scale on meter.
Possible Cause: High voltage divider resistors (R167 or R168) opened up.
Failure of regulator amplifier tube (V109 or V110).

Section 5
PARTS LIST

Non-Standard Components

Detail No.	Stock No.	Item	Mfr. & No.	Description
T101	6-237C	Power transformer	Triad 7115	750V CT-150 ma w/125V 30 ma, 12.6V CT-6A; herm. sealed 6.3V-3A tap at 5V.
F101	7-0504C	Fuse	Littlefuse	3 amps, 250V.
F102		Same as F101		
I101	21-2228	Mechanical register	Veeder-Root	4 digit, 3 cam.
I102	21-1679	Neon Lamp	NE #51	
I103	21-1677	Lamp		6 volt S.C., bayonet base, .1 A.
I104		Same as I103		
B101	9-2743	Fan motor	Scruggs	
J101	17-0849	Chassis connector	IPC 2700	Low voltage BNC type
J102	17-0691	Chassis connector	IPC 27000	High voltage type.
J103	17-1748A	Chassis connector	Cinch 12844	2-wire female, 115 v.
J104	17-1665	Chassis connector	Cannon 2061-2	AN3102A-18-1S
J105		Same as J104		
J107	17-2286	Chassis connector	GE 2711	Male recessed.
J108	17-2509	Chassis connector	Cannon 2059-2	AN3102A-16S-1S
S101	12-3188	PB switch	Switchcraft 1009	TPDT normally closed
S102	12-1909	Toggle switch	C-H 8373K-7	DPDT
S103		Same as S102		

Detail No.	Stock No	Item	Mfr. & No.	Description
S104	12-2654	Selector switch	Oak type DL	12-position.
S105		Same as S102		
S106	12-1642	Toggle switch	C-H 8370K8	DPST
S107		Same as S106		
CR101	8-2224	Selenium rectifier	Radio Receptor 851	Sel 851
CR102	8-1699	Selenium rectifier	Radio Receptor 5M1	Sel 5M1
CR103		Same as CR102		
E101	20-3212	Binding post strip	EBY 7190	Binding post strip

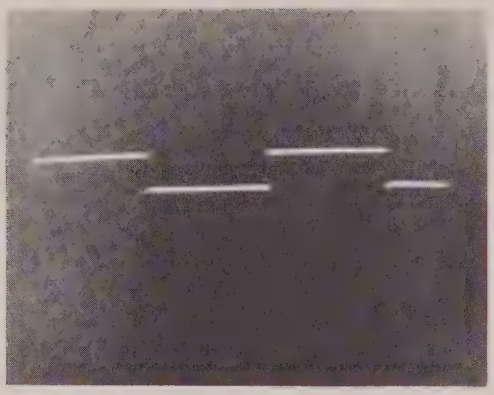
Vacuum Tubes*

Tube	No. required Per Unit
OB2	1 (V114)
5V4G	1 (V111)
6AH6	1 (V101)
6AU5	1 (V112)
6AU6	1 (V113)
6U8	1 (V110)
12AT7	1 (V102)
991	1 (V108)
5963	5 (V103, V104, V105, V106, V107)

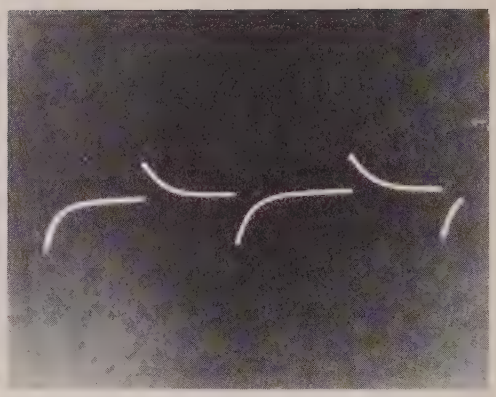
* This list does not include tubes in Decimal Counting Units.

NOTE

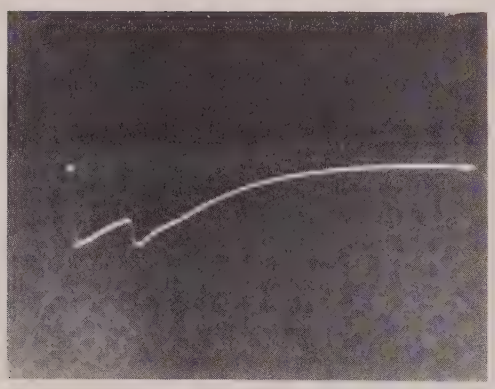
The following photographs were taken with a 4 x 5 Speedgraphic from a Tektronix Model 511D oscilloscope.



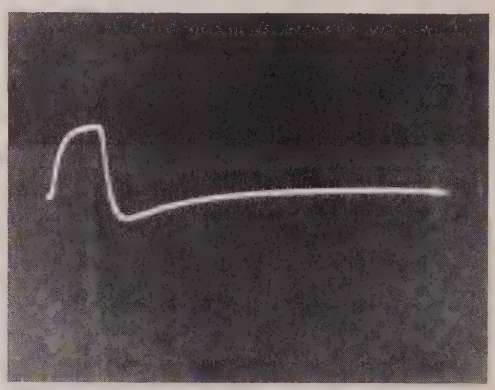
A. Input applied to J101, 1 kc square wave 0.3 volt peak to peak amplitude.



B. Resulting waveform on plate (pin 5) of V101, repetition rate of 1000 per second.

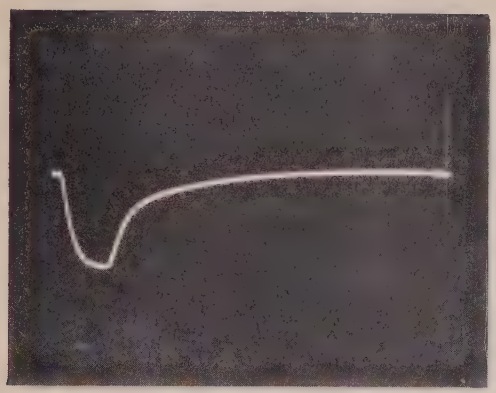


C. Waveform at pin 7 of V102. The second peak is caused by the triggering action which takes place in V102. The two peaks are separated by 1.5 microseconds.

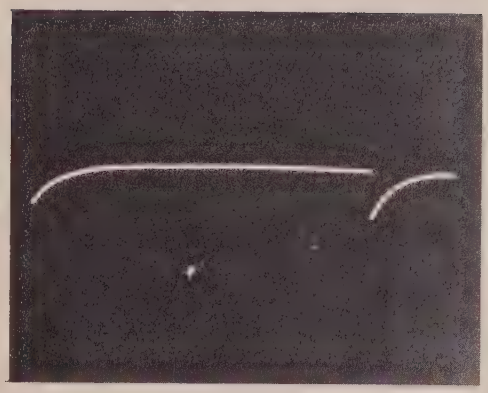


D. Trigger output pulse at pin 1 of V102. Width of pulse at base line is 1.5 microseconds.

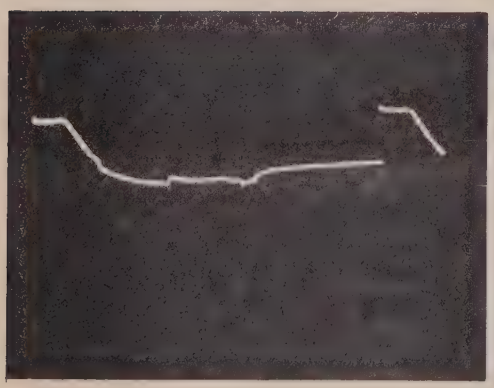
FIGURE 4A TYPICAL WAVEFORMS, MODEL 2105



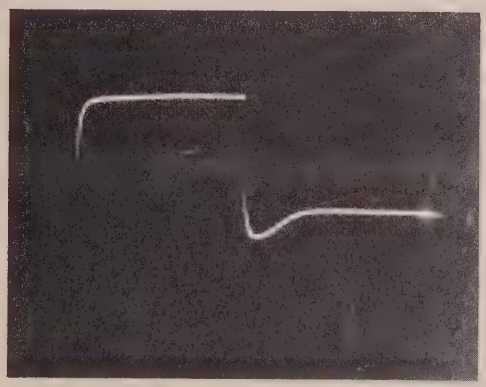
E. DCU driving pulse at pin 5 of first DCU.



F. Differentiated output of second DCU at pin 2 of V104, repetition rate 10 per second.

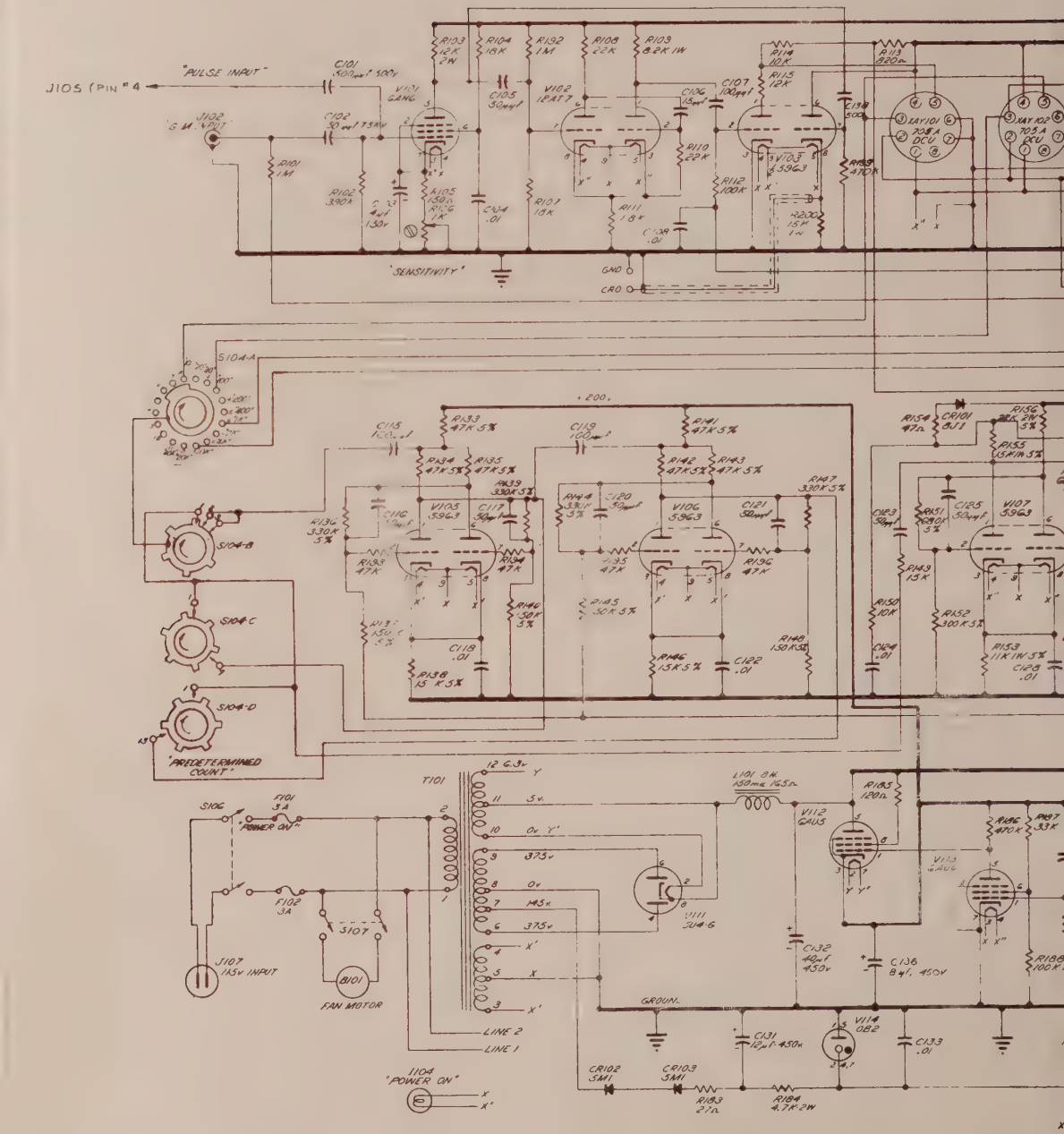


G. Waveform across coil of relay K101, repetition rate 10 per second.



H. Waveform at pin 1 of V107. S102 in Manual position, total trace width 30 milliseconds.

FIGURE 4B TYPICAL WAVEFORMS, MODEL 2105



NOTE:
ALL RESISTORS ½W 10% UNLESS NOTED OTHERWISE.
" CAPACITORS 600v " " " "
CAPACITOR VALUES GREATER THAN "ONE" μμf UNLESS NOTED OTHERWISE.
CAPACITOR VALUES LESS THAN "ONE" μf " " " "
" RESISTORS R201 THRU R212 6.8M, 1W, 5%

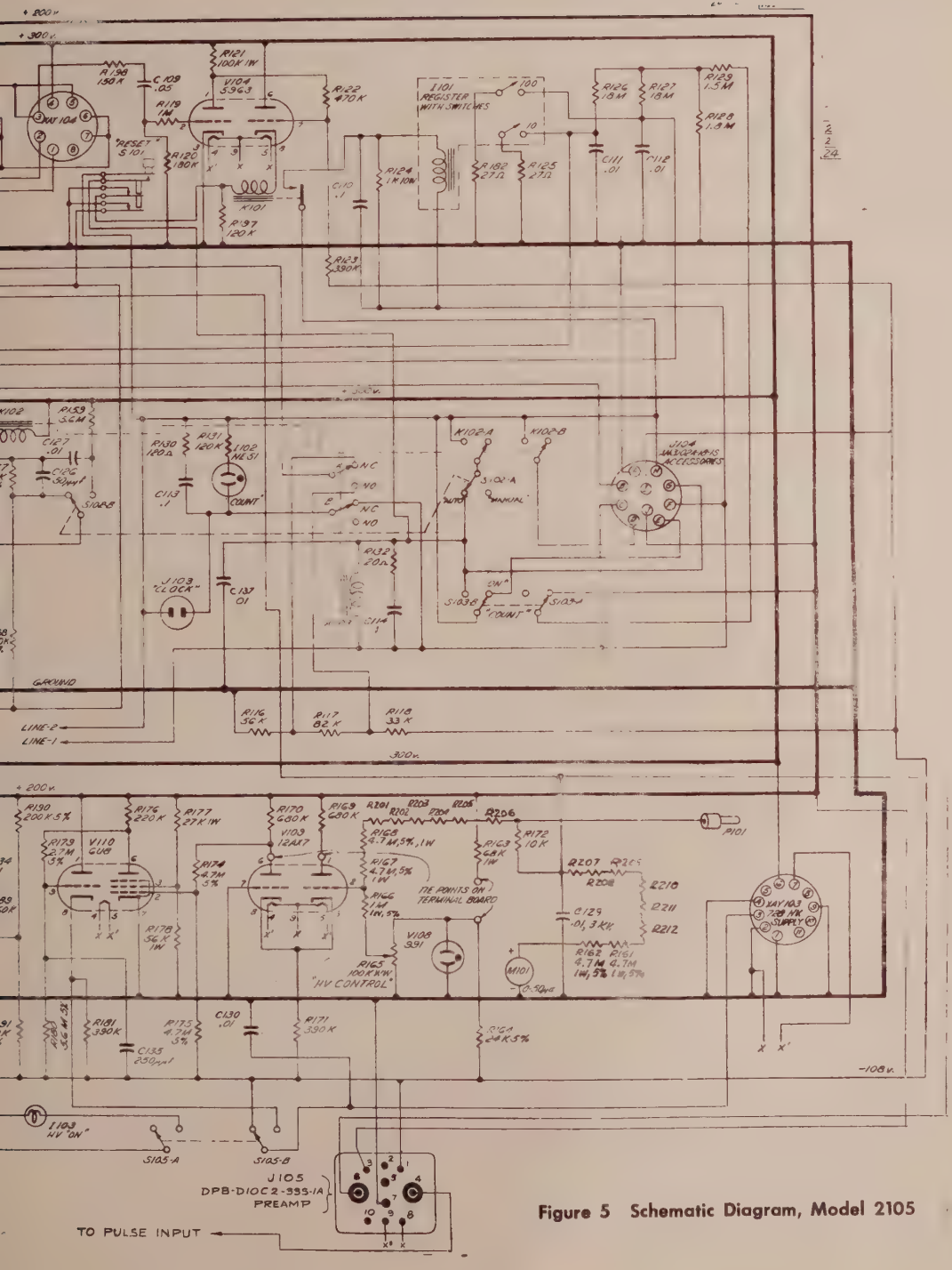


Figure 5 Schematic Diagram, Model 2105

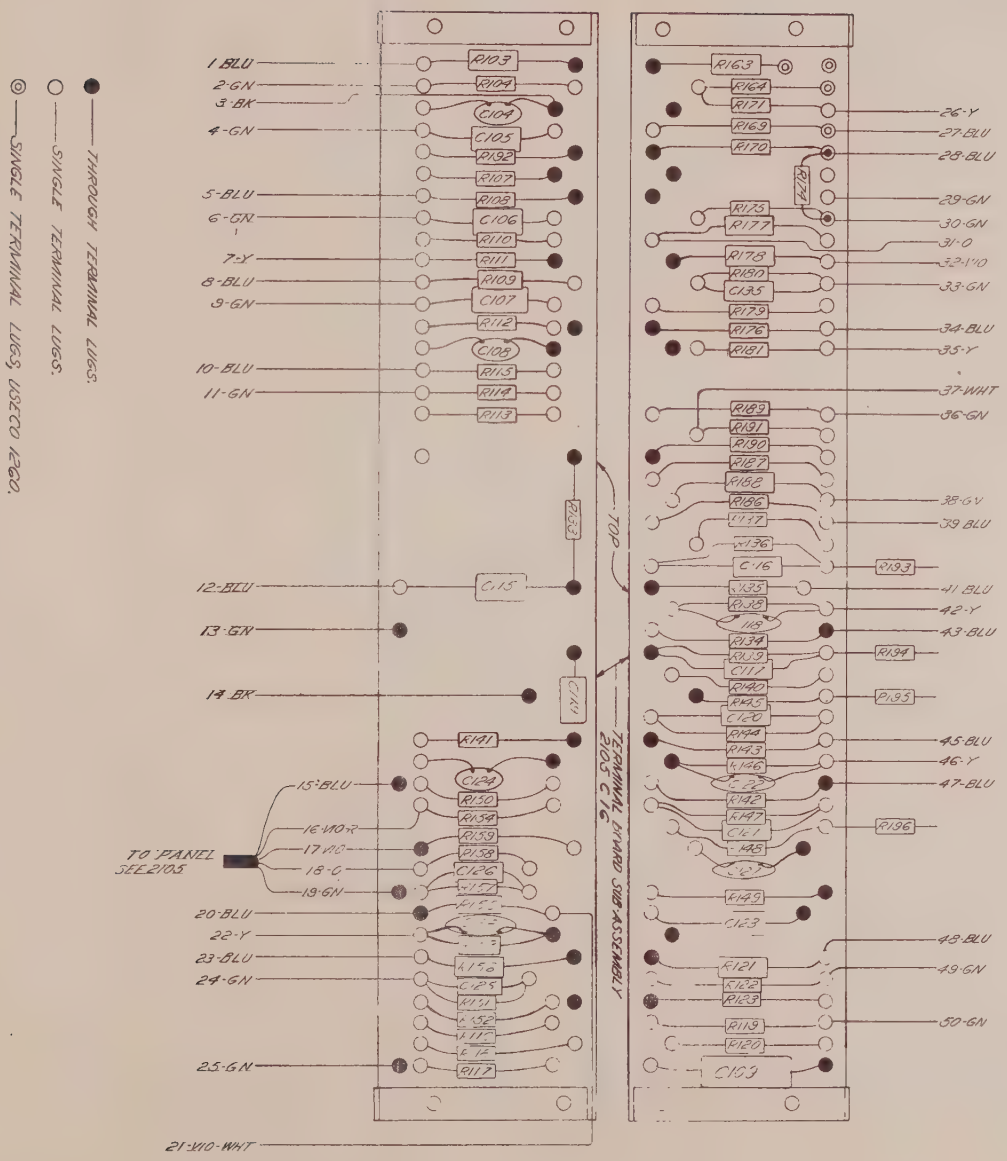


Figure 6 Diagram, Principal Terminal Board

BASING —
1. GND
2. 6.3 VAC
3. SCREEN
4. GROUND
5. N.C.
6. *300 VDC
7. 6.3 VAC
8. N.C.
9. GROUND
10. NC
11. NC

UNLESS INDICATED OTHERWISE:
ALL RESISTORS ½ WATT & 10%;
CAPACITORS 500 OR 600 VOLTS;
FRACTIONAL VALUED CAPACITORS
IN uF; INTEGRAL VALUES uuF.

POSITIVE: STRAP RED TO CENTER
NEGATIVE: STRAP GREEN TO CENTER.

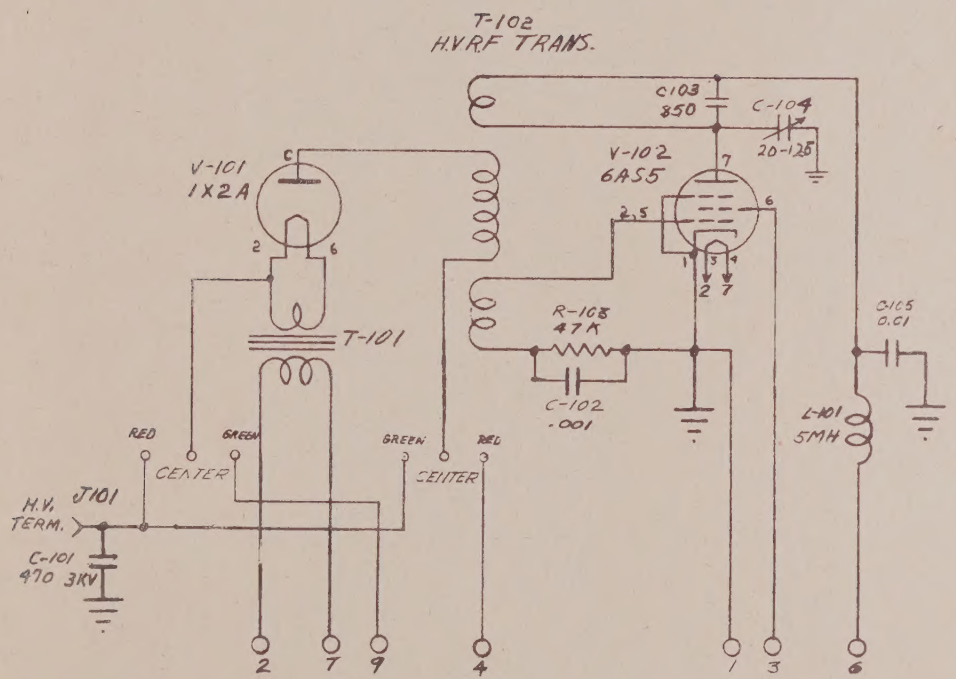


Figure 7 Schematic Diagram, Model 728 Power Supply